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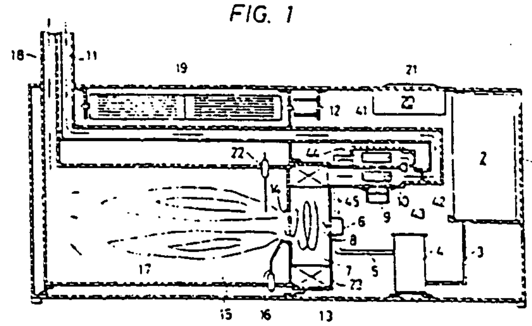
(54) Electric liquid atomizing apparatus.

(57) An apparatus for atomizing a large quantity of liquid such as water, liquid fuels, lotions or the like comprises an atomizer including a body having a pressurization cavity for containing a liquid, a nozzle base mounted on the body and having a plurality of orifices communicating with the pressurization cavity, an electric vibrator mounted on the body, and an electric circuit means for applying an alternating voltage to the electric vibrator to vibrate the latter back and forth, for thereby expelling a large quantity of liquid droplets of small and uniform diameter successively out of the orifices.

FIG. 1



EP 0 049 636 A1

Croydon Printing Company Ltd

TITLE OF THE INVENTION

ELECTRIC LIQUID ATOMIZING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to an apparatus for atomizing large quantities of liquid such as liquid fuels, water, lotions or the like.

Prior Art:

A variety of liquid atomizers have heretofore been proposed and practiced in the art. One such known atomizer utilizes a pump for ejecting a liquid under pressure through a nozzle. According to another conventional atomizing apparatus, liquid droplets are allowed to fall onto a rotating body and caused upon hitting the latter to be atomized under centrifugal forces. These prior systems, however, require a high-pressure pump or a high-speed motor, are large in size and costly to construct, and cannot achieve a satisfactory degree of liquid atomization. There are also known ultrasonic atomizers which incorporate an ultrasonic vibrator for breaking up the liquid into small droplets. One form of such ultrasonic atomizer includes a horn vibrator for amplifying the vibrations from an ultrasonic vibrator up to a level large enough to atomize the liquid supplied to a distal end of the horn. This ultrasonic vibrator is disadvantageous in that the vibration amplifying horn is complex in structure, difficult to machine, expensive to manufacture, and fails to produce liquid droplets of satisfactory diameter. The vibrator necessitates a liquid supplying

device such as a pump, and hence is large-sized and cannot be built inexpensively. Another known ultrasonic atomizer comprises an ultrasonic vibrator mounted on the bottom of a liquid container for directly transmitting ultrasonic energy into the liquid to atomize the latter with the ultrasonic energy that reaches the surface of the liquid in the container. Although the ultrasonic atomizing apparatus for direct ultrasonic liquid atomization needs no liquid supplying unit such as a pump and atomizes the liquid into desired droplets, the atomizer consumes a great amount of electric energy for atomization and produces ultrasonic vibrations at quite a high frequency which ranges from 1 MHz to 2 MHz. Such high-frequency ultrasonic vibrations have an increased level of undesirable radiation which has a great potential for causing disturbance in radio waves to be received by television and radio receivers. Therefore, the atomizer is required to be equipped with a vibrator driving circuit and a noise prevention means, and hence is costly to construct.

U.S. Patent NO. 3,683,212 to Zoltan, patented August 2. 1972, discloses a system for ejecting a train of small droplets of liquid through a single orifice in response to pressure increases due to changes in volume of a piezoelectric element to which electric command pulses are applied. The disclosed system can produce a succession of droplets of uniform diameter and is suitable for use in ink jet printers and recorders. The prior droplet ejecting system, however, cannot be used in a liquid fuel burner or a humidifier which atomizes

a large amount of liquid, at a rate of 1 to 20 cc/min., into small uniform droplets. More specifically, when the voltage of supplied pulses is increased in order to produce droplets in large quantities, the liquid is broken up into droplets of large diameter. Application of pulses at a higher frequency makes it impossible to eject liquid droplets out of the orifice. The system of Zoltan therefore fails to form droplets of small and uniform diameter in large quantities.

In U.S. Patent NO. 3,747,120 to Stemme, patented July 17, 1973, an apparatus for ejecting a succession of small droplets is effective for use in recording devices such as an ink jet printer, but is unable to generate large quantities of atomized liquid as small uniform droplets. The disclosed droplet generator comprises a plurality of superimposed plates having small-diameter channels held in coaxial alignment, a structure which is quite difficult to assemble.

Experiments conducted by the present inventors indicated that the system as shown in U.S. Patent NO. 3,747,120 produced liquid droplets at a rate of about 0.5 cc/min. even when the droplets are of an excessively large diameter, and ejected liquid droplets of smaller diameter at an approximate rate of about 0.1 to 0.2 cc/min. Thus, Zoltan's system has experimentally been proven to fail to eject a large quantity of liquid droplets of small and uniform diameter.

SUMMARY OF THE INVENTION

In accordance with the present invention, an atomizer includes a nozzle base having a plurality of orifices defined

therein and attached to a body of the atomizer, the orifices communicating with a pressurization cavity in the body. An electric vibrator comprising a vibration plate and a plate of piezoelectric ceramics bonded to the vibration plate is mounted on the body, the electric vibrator is responsive to an alternating voltage applied thereacross for vibratory movement to expel the liquid as fine uniform droplets out of the cavity through the orifices. An electric control circuit is connected to the electric vibrator for applying the alternating voltage thereacross to displace the vibrator back and forth periodically for successive ejection of the liquid droplets. The electric control circuit includes a means for changing the alternating voltage in order to produce liquid droplets controllably in a variety of quantities.

It is an object of the present invention to provide an atomizing apparatus for producing a large quantity of fine and uniform droplets of liquid.

Another object of the present invention is to provide a liquid atomizing apparatus which is relatively simple in structure, reliable in operation, small in size, and inexpensive to manufacture.

Still another object of the present invention is to provide an atomizing apparatus including means for producing atomized liquid in a variety of controlled quantities.

Still another object of the present invention is to provide an atomizing apparatus which will consume a relatively small amount of energy for liquid atomization.

The above and other objects, features and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings in which some preferred embodiments of the present invention are shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal cross-sectional view of a liquid-fuel burner which incorporates an electric liquid atomizing apparatus according to the present invention;

FIG. 2 is an enlarged cross-sectional view of an atomizer of the present invention;

FIG. 3 is an enlarged plan view of a nozzle base in the atomizer shown in FIG. 2;

FIG. 4 is an enlarged diametrical cross-sectional view of the nozzle base illustrated in FIG. 3;

FIG. 5 is an enlarged diametrical cross-sectional view of a modified nozzle base;

FIG. 6 is a circuit diagram of a voltage generator for applying an alternating voltage to an electric vibrator in the atomizer;

FIG. 7 is a diagram illustrative of waveforms of three alternating-voltage signals for driving the electric vibrator at maximum, medium, and minimum power requirements;

FIG. 8 is an enlarged fragmentary cross-sectional view of the atomizer as it is in a droplet-expelling mode of operation with the electric vibrator bent in one direction;

FIG. 9 is a view similar to FIG. 7, showing the atomizer as it is in a liquid-supplying mode of operation with the electric vibrator displaced in the opposite direction;

FIG. 10 is a cross-sectional view of an atomizer according to another embodiment;

FIG. 11 is a cross-sectional view of an atomizer according to still another embodiment;

FIG. 12 is a cross-sectional view of an atomizer in accordance with still another embodiment; and

FIG. 13 is a cross-sectional view of an atomizer in accordance with still another embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As illustrated in FIG. 1, a liquid-fuel burner comprises a casing 1, a fuel tank 2 housed in the casing 1, a fuel leveller 4 mounted in the casing 1 and connected to the fuel tank 2 by a pipe 3 for being supplied with a liquid fuel from the tank 2, and an atomizer 6 disposed in the casing 1 and connected to the fuel leveller 4 by a pipe 5 through which the liquid fuel can be delivered from the fuel leveller 4 to the atomizer 6. The atomizer 6 atomizes the supplied liquid fuel and ejects fuel droplets 8 thus atomized into a mixing chamber located adjacent to the atomizer 6.

Ais is introduced by an air delivering system comprising an air charging fan 10 which is driven by a motor 9 through an air delivery pipe 11. The fan 10 supplies draft to an air rotator or swirling device 13 for supplying a swirling

stream of air into the mixing chamber 7, in which air is mixed with the fuel droplets 8. The fuel-air mixture as it swirls is discharged through a discharge port 14 into a combustion chamber 15. The mixture is then ignited by an ignition means 16, producing flames 17. An exhaust gas is discharged from the combustion chamber 15 through an exhaust pipe 18 that extends out of the casing 1. The heat energy generated by the combustion in the combustion chamber 15 is transferred to air forced by a fan 19 to move around the combustion chamber 15, the heated air being dischargable into a room in which the liquid-fuel burner is installed. Thus, the liquid-fuel burner serves as a heater for discharging hot air.

The liquid-fuel burner is equipped with a controller 20 for controlling operation of the burner, i.e., operation of the fans 10, 19, the atomizer 6, the ignition means 16 and other components in response to command signals from a control panel 21, and signals from a frame condition detector 22 and a room temperature detector (not shown).

As illustrated in FIG. 2, the atomizer 6 comprises a body 24 having a first pressurization cavity 25 which is in the shape of an exponential horn. The pressurization cavity 25 has a cylindrical front end portion 26 having an inside diameter of 3 mm on which there is mounted a circular nozzle base 27 peripherally sealed by a gasket 28 and held in position by a holder plate 29 that is fastened to the body 24 by screws 30. The nozzle base 27 includes a central curved or partispherical portion or nozzle 31 having a plurality (thirty seven

as illustrated in FIG. 3) of orifices 32 that are arranged in rows and spaced at equal intervals or equidistantly from adjacent ones. Each of the orifices 32 is horn-shaped or conically tapered as shown in FIG. 4 such that an outlet end thereof on the convex side is smaller in cross-sectional area than an inlet end thereof on the concave side. The outlet end of each orifice 32 has a diameter of 80 μm and the inlet end thereof has a diameter of about 90 to 100 μm. A modified nozzle base 27 illustrated in FIG. 5 comprises a curved portion 31 having therein a plurality of orifices 32 each in the form of a combined bowl and aperture.

The nozzle base 27 is made from a plate of stainless steel having a thickness of 50 μm by first defining the orifices 32 in the plate through a one-sided etching process, and then embossing the central curved portion 31. With the one-sided etching process, the horn-shaped orifices 32 can be formed with utmost ease and relatively inexpensively.

In FIG. 2, a circular electric vibrator 35 is mounted in the cavity 25 at a rear end portion thereof, the electric vibrator 35 comprising a vibration plate 33 of metal and a plate 34 of piezoelectric ceramics bonded to the vibration plate 33, the vibration plate 33 being integral with a support 36 attached to the atomizer body 24. The body 24 and the support 36 jointly define a second cavity 37 therebetween which is held in fluid communication with the first cavity 25 through a passage 38 extending circumferentially all around the electric vibrator 35.

The pipe 5 is connected to a lower end of the body 24 in communication with the second cavity 37 through a fuel filling channel 46 in the body 24. The fuel leveller 4 controls the level of the liquid fuel to be maintained at the position A (FIG. 2) in the pipe 5 just below the atomizer 6. The atomizer body 24 is secured by screws 39 to a wall 23 of the mixing chamber 15 with the orifices 32 opening into the mixing chamber 15. The body 24 is connected at an upper end thereof to an air suction pipe 45 coupled to a connector pipe 43 (FIG. 2) disposed upstream of the fan 10 through an air suction fan 41 housed in an air suction chamber 44 and coaxially connected to the fan 10 for corotation. The air delivery pipe 12 is coupled through an orifice or restrictor 42 to the connector pipe 43. The air suction pipe 45 is held in fluid communication with the second chamber 37 through an air exhausting channel 40 in the body 24. When liquid fuel is supplied through the fuel filling channel 46 into the first and second cavities 25, 37, air is forced out of these cavities 25, 37 through the air exhausting channel 40 into the air suction pipe 45, while preventing the liquid fuel as supplied from leaking out through the orifices 32.

Operation of the liquid atomizing apparatus thus constructed will now be described with reference to FIGS. 1, 2, 6, 7 and 8.

In FIG. 1, when the motor 9 is energized under the control of the controller 20, the air charging fan 10 and the air suction fan 41 are caused to corotate, whereupon there is

developed a negative pressure of about 2 to 3 mm Ag in the connector pipe 43 due to the orifice 42. The air suction fan 41 also developes a negative pressure of about 5 to 10 mm Ag in the air suction chamber 44 and hence in the air suction pipe 45. Since the orifices 32 are extremely small in diameter, the amount of air introduced therethrough into the first cavity 25 is also extremely small. The fuel level is now raised from the position A to the position B as shown in FIG. 2, whereupon the first and second cavities 25, 37 are filled up with the liquid fuel supplied. Thus, the air suction fan 41, the air suction chamber 44 and the air suction pipe 45 jointly serve as a fuel filling system.

The controller 20 includes a means for generating an alternating voltages to be applied to the electric vibrator 35. The means for generating alternating voltages is illustrated in FIG. 6, and waveforms of generated alternating voltages are shown in FIG. 7 at (a), (b), and (c). The alternating-voltage generating means comprises an amplifying output circuit including transistors 47, 48 and 49, capacitors 50, 51, resistors 52, 53, 54 and 55, and an output transformer 56, a Wien bridge oscillator circuit including an operational amplifier 57, a diode 58, capacitors 59, 60, and 61, and resistors 62, 63, 64, 65, 66, 67, and 68, a switching circuit including an N-CH FET (N-channel field effect transistor) 69, a resistor 70, and a transistor 71, and a duty-cycle controlling circuit including transistors 72, 73, capacitors 74, 75, resisters 76, 77, 78, 79 and 80, variable resistors 81, 82, and a switch 83.

The variable resistors 81, 82 and the switch 83 are ganged together by a control 84 such that when the control 84 is actuated in one direction, the resistance of the variable resistor 81 is reduced, the resistance of the variable resistor 82 is increased, and the switch 83 will be closed when the control 84 reaches the end of the stroke in said one direction. The N-CH FET 69, therefore, has a duty cycle D which is rendered continuously variable by the control 84 at a constant frequency within the following range:

$$\text{Minimum value} \leqq D \leqq 1$$

The oscillator circuit can supply the amplifying output circuit with various sine-wave voltage signals, as shown in FIG. 7 at (a), (b) and (c), adjustable by the control 84. An output alternating voltage applied through output terminals 85, 86 across the electric vibrator 35 is variable accordingly and can have waveforms as illustrated in FIG. 7 at (a), (b) and (c). The average power fed to the electric vibrator 35 can easily and reliably be controlled by the control 84. Thus, the variable resistors 81, 82 and the switch 83 jointly constitute a means for adjusting the quantity of fuel droplets ejected by controlling the average power supplied to the electric vibrator 35. The controller 20 also includes a dc power supply 87 for supplying a dc power to the circuits therein.

Application of the alternating voltage across the electric vibrator 35 causes the latter to vibrate, enabling the atomizer 6 to atomize the liquid fuel into fine droplets.

When the sine-wave voltage shown in FIG. 7 at (a), (b), or (c) is applied during its positive half cycle to the electric vibrator 35, the latter bends toward the first cavity 25 as

shown in FIG. 8 causing a pressure increase in the first cavity 25. The pressure buildup is progressively greater toward the nozzle base 27 due to the horn-shaped cavity 25. The liquid fuel is then expelled out of the first cavity 25 through the orifices 32 as small and uniform droplets 8 having a diameter on the order of 50 μm. While in the embodiment illustrated in FIG. 2 the first cavity 25 is horn-shaped, it may be of other shapes since ejection of fuel droplets is primarily dependent in principle on changes in volume of the first cavity which are caused by displacement of the electric vibrator 35. Furthermore, the electric vibrator 35 may be shaped and positioned differently from the foregoing embodiment provided it can cause volume changes in the first cavity to propel fuel droplets through the orifices 32.

Application of the alternating voltage during the negative half cycle enables the electric vibrator 35 to bend away from the nozzle base 27 as illustrated in FIG. 9, whereupon a negative pressure is developed in the first cavity 25 adjacent to the electric vibrator 35, replacing the expelled liquid fuel with an additional amount of liquid fuel that is supplied in the directions of arrows (FIG. 9) through the passage 38. At this time, the liquid fuel is prevented from flowing out of the orifices 32 due to the surface tension of the liquid at the orifices 32. With the passage 38 extending circumferentially around the circular electric vibrator 35, the liquid fuel can smoothly and uniformly be supplied from the second cavity 37 into the first cavity 25. Static pressure on the liquid fuel in the first cavity 25 becomes negative

enough to prevent introduction of air through the orifices 32 into the first cavity 25. The second cavity 37 reduces resistance to the flow of liquid into the first cavity 25, an arrangement which also assists in smooth and balanced supply of the fuel into the first cavity 25 and prevention of air flow back into the first cavity 25 under the negative pressure buildup therein.

The electric vibrator 35 can be bent or displaced back and forth repeatedly in response to application thereacross of one of alternating voltages, the waveforms of which are shown in FIG. 7 at (a), (b), and (c), to eject liquid droplets 8 of a very small and uniform diameter in a controlled quantity which ranges from 1 cc/min. to 20 cc/min.

There would be a danger for the nozzle base 27 to vibrate under the influence of pressures produced by the electric vibrator 35, causing influx of air into the first cavity 25 through the orifices 32. Presence of such air in the first cavity 25 reduces the pressure buildup caused by the electric vibrator 35 to an extent which is sufficient to prevent smooth and reliable ejection of fuel droplets 8 through the orifices 32.

Such a danger or difficulty however is completely eliminated by the curved nozzle portion 31 of the nozzle base 27, which gives the latter an increased degree of rigidity making the nozzle base 27 resistant to vibrations. The curved or parti-spherical nozzle portion 31 can disperse fuel droplets 8 in different directions in a wide conical space in which the

droplets 8 are prevented from being re-united into larger droplets, and hence are available of a uniform diameter. The small uniform fuel droplets 8 can easily be mixed with air which is introduced in a swirling motion to help carry away the droplets 8 into the combustion chamber 15 or to produce the fuel-air mixture.

With the horn-shaped or conical orifices 32, the liquid fuel is subjected to an increased pressure in the orifices 32 while being expelled therethrough under the pressure build-up developed by the electric vibrator 35, and can be accelerated at the outlets of the orifices 32 up to a speed great enough to overcome the surface tension of the liquid fuel at the orifice outlets. The horn-shaped orifices 32 also assist the liquid fuel in the first cavity 25 in separating from the ejected droplets 8 when the electric vibrator 35 is deflected away from the nozzle base 27, as shown in FIG. 9.

FIG. 10 shows an atomizer according to another embodiment of the present invention. The atomizer comprises a nozzle base 27 bonded to a body 24, and an electric vibrator 35 located remotely from the nozzle base 27 and outwardly of a cavity 25 in the body 24.

According to another embodiment illustrated in FIG. 11, an electric vibrator 35 is in the form of a hollow cylinder disposed around a cavity 25.

An atomizer in accordance with still another embodiment shown in FIG. 12 includes a flat nozzle base 27 integral with a body 24 of the atomizer.

As illustrated in FIG. 13, an atomizer according to still another embodiment has an annular or doughnut-shaped second cavity 37 defined in a doby 24 in surrounding relation to a first cavity 25, the first and second cavities 25, 37 being held in fluid communication with each other by four passages 38 (two shown) positioned near the outer periphery of an electric vibrator 35 and angularly spaced 90 degrees from adjacent passages 38. The passages 38 are spaced equidistantly from the axial center of the electric vibrator 35 and hence the first cavity 25 for smooth and equally distributed supply of liquid fuel from the second cavity 37 into the first cavity 25.

Advantages accruing from the arrangement of the present invention are as follows: No separate liquid supply unit or pump is required as the atomizer is of the self-priming type for automatically replacing discharged droplets in the first cavity 25 through the liquid filling channel 46. Therefore, the atomizing apparatus is relatively simple in structure, small in size, and inexpensive to construct. The nozzle base 27 has a plurality of orifices 32 for ejecting therethrough fine and uniform liquid droplets in large quantities in response to a pressure increase in the cavity 25 caused by the electric vibrator 35. The air exhausting channel 40 allows air to be discharged out of the cavities 25, 37 when liquid fuel is introduced through the liquid filling channel 46. No liquid fuel is caused to flow out through the orifices 32 at the time of charging the cavity 25 with the liquid fuel. The curved portion 31 serves as a stiffener for the nozzle

base 27 for protection against vibration of the latter during operation of the atomizer 6. Accordingly, influx of air into the cavity 25 through the orifices 32 is prevented for stabilized liquid atomization. The electric vibrator 35 consumes a small amount of electric power since it requires only a vibratory energy to be applied to the liquid which fills the cavity 25. The atomizing apparatus also has a relatively small power requirement and produces a reduced amount of noise or unnecessary energy radiation. The quantity of liquid droplets expelled can easily be adjusted by controlling the average power with which the electric vibrator 35 is energized. The horn-shaped orifices 32 can easily be formed using the one-sided etching process. The orifices 32 thus shaped are conducive to generation of small and uniform liquid droplets. The second cavity 37 and the symmetrically defined passage 38 permit liquid to be introduced smoothly into the first cavity 25 without developing an excess negative pressure in the latter, a structure which assures stable liquid atomization. The air delivery system and the fuel filling system are coupled with each other for joint operation. This structure serves as a fail-safe device to prevent an atomization process from being started while the air delivery system is not operating. With the air delivery system and fuel filling system thus combined, the atomizing apparatus is simpler in structure and less costly to manufacture. The fuel filling system is operated under air pressure and hence is relatively simple and inexpensive.

CLAIMS

1. An atomizing apparatus comprising:

(a) a body having a cavity for containing a liquid therein;

(b) a nozzle base mounted on said body and having a plurality of orifices defined therein and communicating with said cavity;

(c) an electric vibrator mounted on said body and movable to pressurize the liquid in said cavity for ejecting a quantity of the liquid as atomized droplets through said orifices; and

(d) electric means for applying an alternating voltage to said electric vibrator to displace the latter back and forth periodically, whereby said atomized droplets can be expelled successively out of said orifices.

2. An atomizing apparatus according to claim 1, said body including an liquid filling channel for supplying therethrough the liquid into said cavity, and an air exhausting channel for discharging therethrough air from said cavity.

3. An atomizing apparatus according to claim 1 or 2, said nozzle base including a curved portion, said orifices being defined in said curved portion.

4. An atomizing apparatus according to claim 1,2 or 3, said electric means including means for adjusting the quantity of droplets ejected by controlling an average power supplied to said electric vibrator.

5. An atomizing apparatus according to any of claims 1 to 4, each of said orifices being in the shape of a horn, and having an inlet opening into said cavity and an outlet opening away from said cavity, said inlet being larger in cross-sectional area than said outlet.

6. An atomizing apparatus according to any of claims 1 to 5, said orifices being formed in said nozzle by a one-sided etching process.

7. An atomizing apparatus according to any of claims 1 to 6, said body including a second cavity for supplying the liquid to said first-mentioned cavity, and a passage by which said first-mentioned cavity and said second cavity are held in fluid communication with each other.

8. An atomizing apparatus according to claim 7, said passage being disposed adjacent to said electrical vibrator and symmetrically with respect to the axial center of said electrical vibrator.

9. An atomizing apparatus according to any of claims 1 to 6, further including means for filling the liquid in said cavity.

10. An atomizing apparatus according to claim 9, including means operatively coupled with said filling means for delivering air to carry therewith said atomized droplets expelled out of said orifices.

11. An atomizing apparatus according to claim 10, said filling means being responsive for its operation to an air pressure developed by said air delivering means.

Although various preferred embodiments have been shown and described in detail, it should be understood that many changes and modifications may be made therein without departing from the scope of the appended claims.

FIG. 1

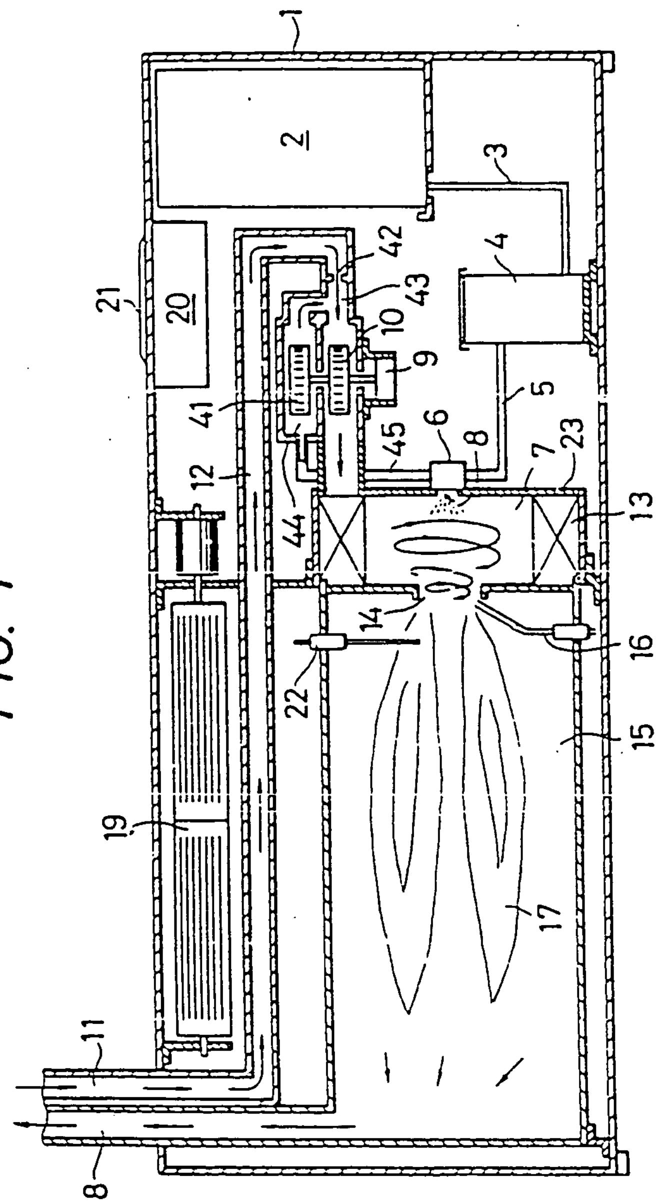


FIG. 2

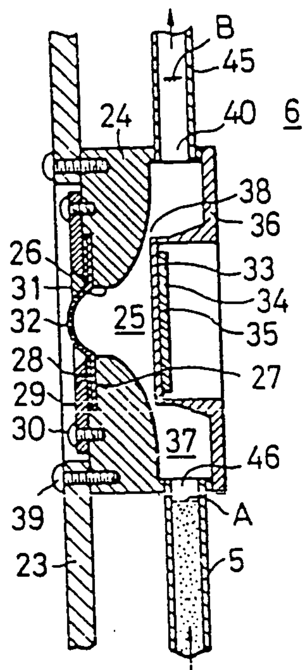

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FIG. 3

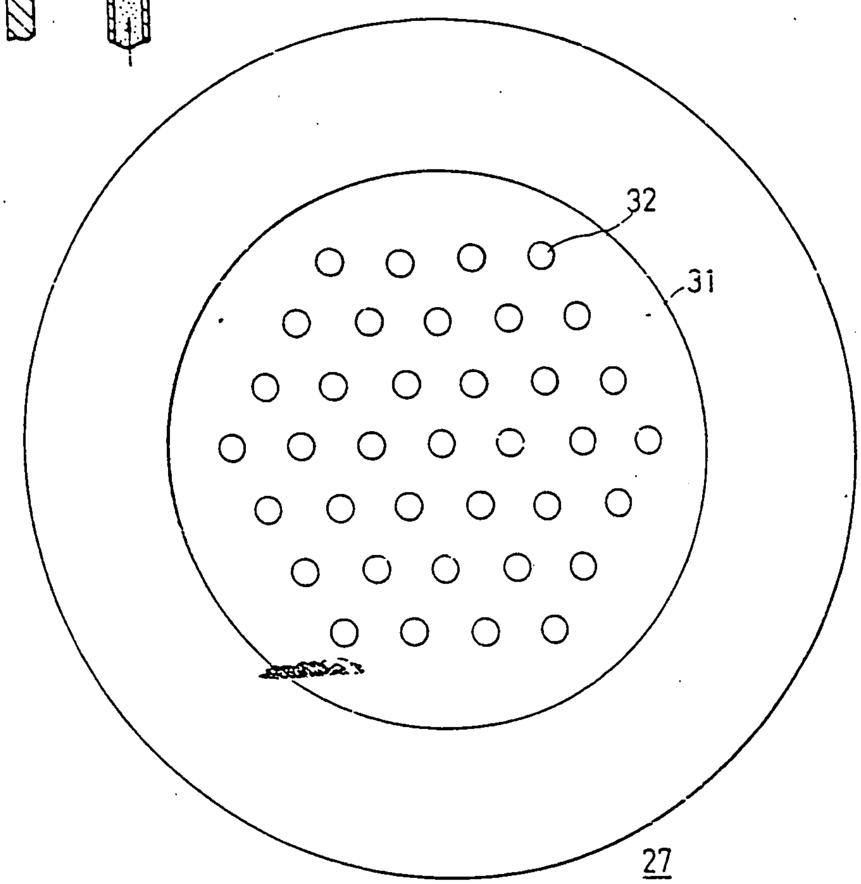
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FIG. 4

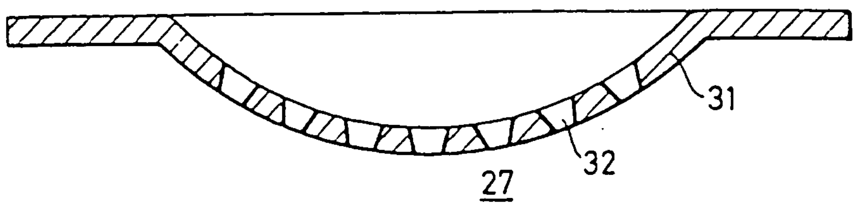


FIG. 5

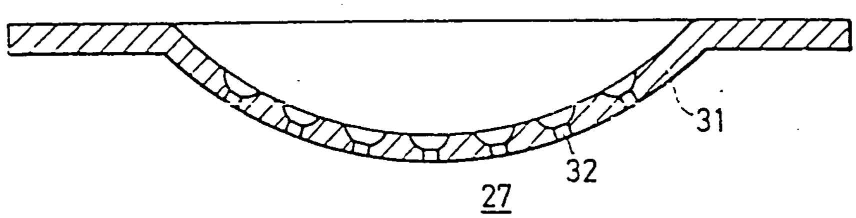
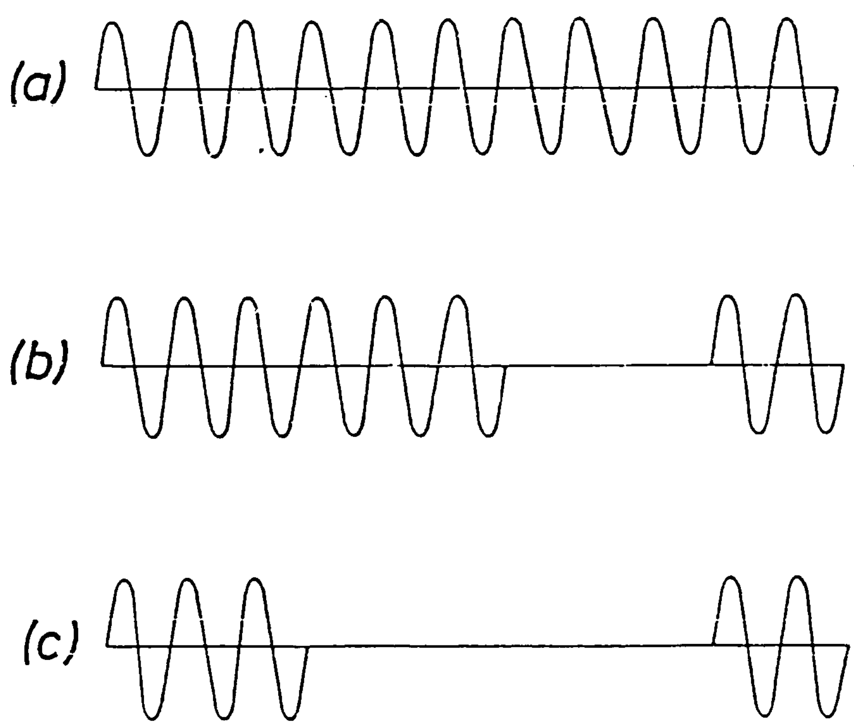


FIG. 7



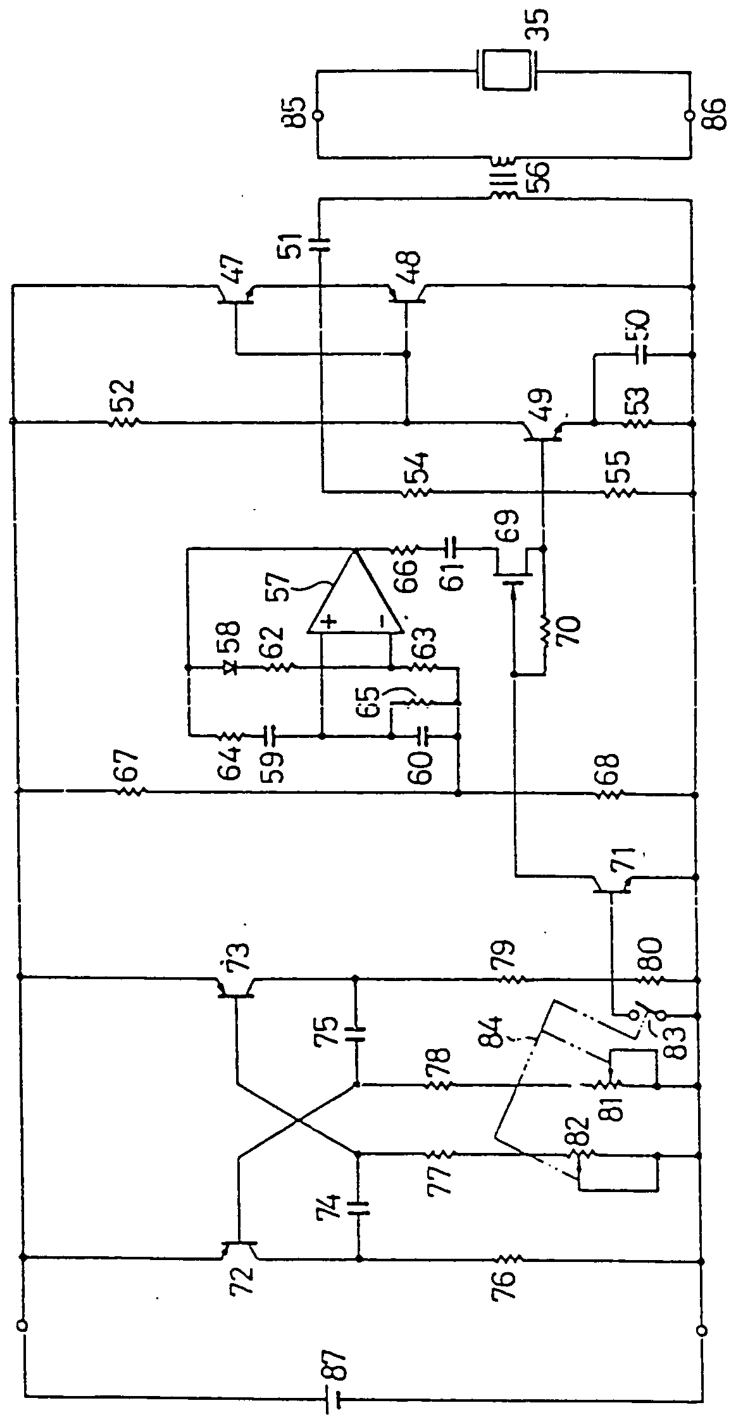

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FIG. 6

FIG. 8

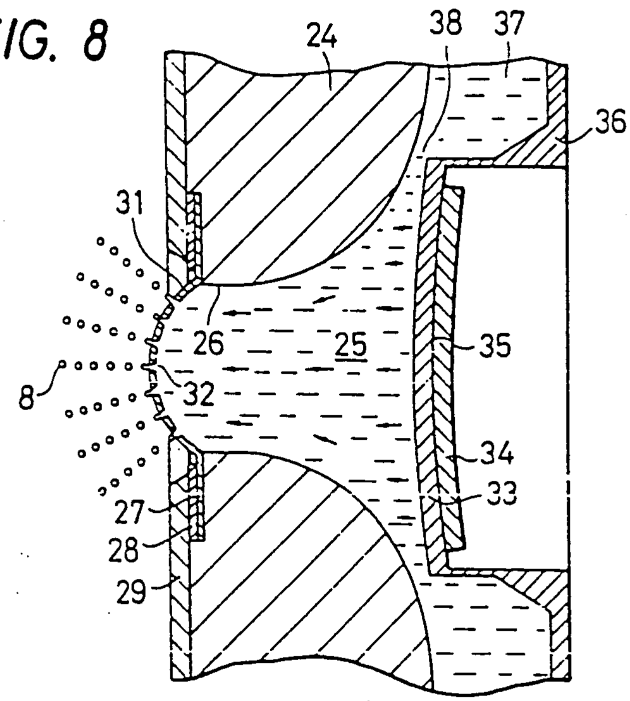
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FIG. 9

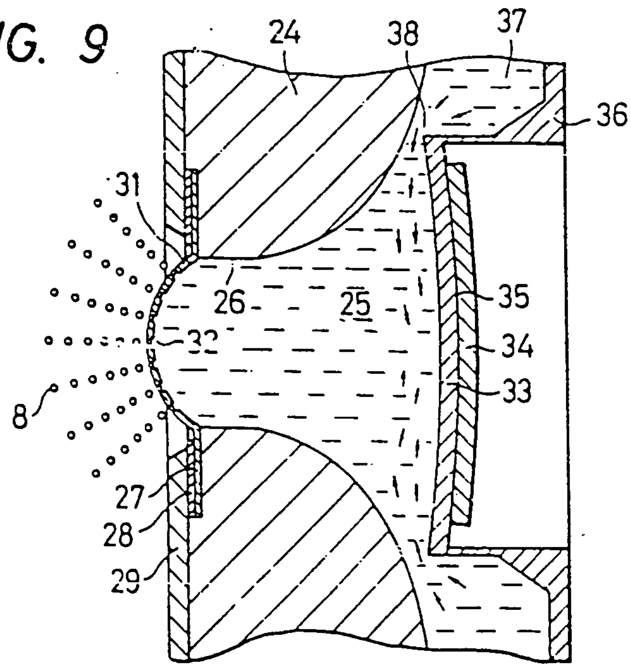
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FIG. 10

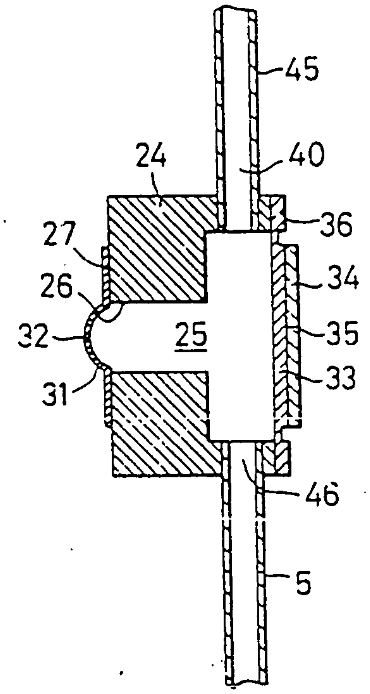


FIG. 11

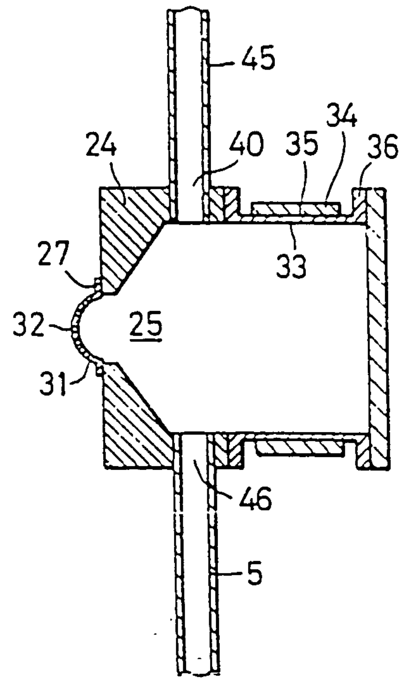


FIG. 12

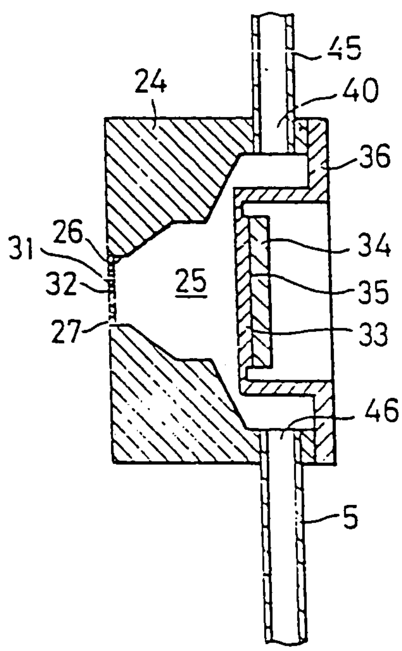
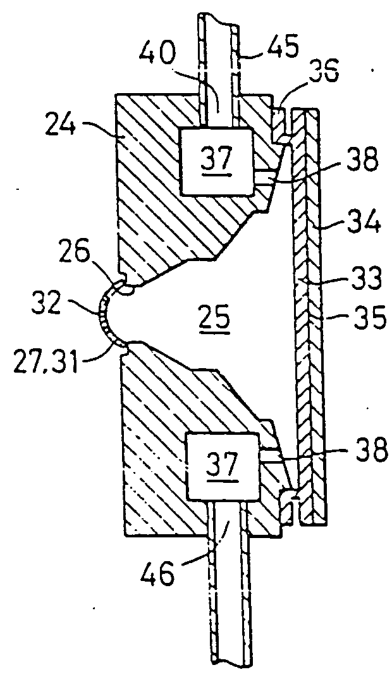


FIG. 13



0049636

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 81 30 4631

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	TRANSACTIONS OF THE ASAE, vol. 17, no. 1, January/February 1974, pages 183-187 Michigan, U.S.A. L.F. BOUSE et al.: "Cyclic disturbance of jets to control spray drop size" * Pages 183,184 *	1-3,5, 9	B 05 B 17/06 F 23 D 11/34
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	JP - A - 55 94665 (TATEISHI DENKI K.K.) * Abstract *	4	

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

B 05 B
F 23 D
B 41 J

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same category
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons
&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11-01-1982	COLPAERT

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